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ABSTRACT

The monograph describes the development of verbal behavior over a 20-year period in two deaf Japanese children (5- and 7-years-old when first contacted by the author) with whom previous training attempts had failed. It is noted that prior training methods which had succeeded with Laura Bridgman and Helen Keller failed with these two children. A detailed analysis of the problem is given which results in differentiating between aboriginal signs (purely instinctual) and constructive signs (the conscious forming of particular communicative patterns), subdividing constructive signs into symbolic signs and pattern discriminative signs, and further subdividing pattern into discriminative signs gestalt-qualitative signs and synthetic signs (the ordering of phonemes or alphabetical units). It is explained that the analysis led to the establishment of the following training program policies: the acquisition of the synthetic sign system as the primary goal and Japanese Braille as the first synthetic sign system to be learned. Explained is the use of the matching technique as the primary training method with rewards given for successful performance. A chart details the training steps leading to the acquisition of Braille from steps in learning to match on the basis of shape to steps in learning to match objects with their names in Braille. Also detailed are steps in the acquisition of the vibration method of producing vocal signs from controlling lip formation to integrating lip formation, breathing, and throat tension. Stressed is the role of a synthetic sign system in the organization of behavior for the deaf blind. (DB)

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FORMATION OF VERBAL BEHAVIOR OF DEAF-BLIND CHILDREN

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FOREWORD

The latter part of my title, "the deaf-blind child," is not a popular subject in psychology. For this reason, I am afraid that the topic of this talk may not have caught the immediate interest of many of you. On the other hand, the first part of the title, "verbal behavior," is a much discussed subject in every branch of psychology. Therefore, although the combination of these two may sound peculiar, I chose this topic with the hope that it might be of some value to you.

It has been 20 years since we had our first contact with the two children I am going to talk about. They were totally deaf and blind from an early age. Since then we have been in contact, directly or indirectly, with other deaf-blind people and also with individuals who have various kinds of difficulties in verbal behavior. The experience we derived from working with these two children has proved to be of great help in dealing with other similar cases. I would therefore like to present these two cases today, focusing upon the early stages in the long process of their acquisition of verbal behavior.

Twenty-five minutes of the hour assigned to me will be used to show a film. This film consists of excerpts from our photographic record of our first three years of training of these two children. I regret that the film is too short to show the growth process clearly, but I hope it will give you an idea of the atmosphere in which we worked.

PROBLEM

One deaf-blind child (Tadao, male, age 5:1, loss of sight and hearing at age 1:9) entered a school for the blind in 1949. He was the first deaf-blind child to be admitted to a school for the blind in Japan. A year and a half later, another deaf-blind child (Shigeko, female, age 7:3, loss of sight and hearing at age 1:3) entered the school. Both were totally deaf and blind before they were two years old. Neither had made significant progress in learning any of the basic habits of life: walking, dressing and undressing, eating, excretion, keeping themselves clean, sleeping at regular hours, etc. These habits were thus the first things they had to learn at school. They showed only very gradual progress at the beginning, but from early 1952 on their rate of progress accelerated. In addition to these basic habits, they had learned about thirty different gestural signs by this time. This enabled them to carry on their daily life more smoothly. When the staff tried to get them to play with toys, the children came to show interest in them. Shigeko, especially, would walk around the school building by herself touching everything around her and frequently breaking things. After she was taught how to play with the form-board, peg-board, and medal-sorting box she continued to play with them by herself.

Laura Bridgman (1829–1889) is said to be the first to show the world that a person who is deaf and blind from an early age can learn a language. She lost sight and hearing when she was two years old. At the age of eight, language training was started by the raised-letter method. In six weeks she had learned to match everyday objects such as keys, spoons, knives, etc. with the corresponding words represented in raised Roman letters. Six months later, she was able to spell words by arranging these raised letters correctly. Moreover, she mastered the manual alphabet used by the deaf and was thus able to communicate smoothly with others. It is said that within a year she had acquired language at the level of a normal three-year-old.

Ragnhild Kaata (1873–?), a Norwegian, is said to be the first person to show that a deaf-blind person can communicate by the vibration method. With this method, the message is sent by voice and received through tactile discrimination of vocal movements by placing one's hand on the speaker's mouth and throat. After losing sight and hearing at the age of 3:6, her speech sounds had become too inaccurate to communicate. When she was 14, training in the vibration method was started.

Helen Keller (1880–1968) mastered all of the methods mentioned above in a short period of time and was the first deaf-blind person to go to college. She lost her sight and hearing at the age of 1:8 and began language training by the manual alphabet at the age of seven. In three weeks she learned to associate objects with their corresponding words spelled in the manual alphabet.

These methods which were found successful in the above cases were applied to the two Japanese deaf-blind children. First, the Braille method, which is used in place of raised letters today, was adopted.

The training for Tadao began nine months after he entered school (age 5:10). The instructors at the school tried to get him to associate objects like candy or bread with the corresponding words spelled in Braille. When the number of pairs was increased without assuring that previous pairs had been thoroughly learned, Tadao finally refused to touch the Braille. If they forced him to touch it he would cry and clench his fists, or he would get angry and climb on the desk. He even refused to eat the candies they gave him. After trying for one year, they finally decided to stop the training for a while. Similarly, they began the training for Shigeko with the same method nine months after she entered the school (age 8:1). Since she would not even try to feel the distribution of dots when she touched the Braille letters, they soon stopped the training. After a period of time they resumed the training of both children but again they were unable to get any positive results and were forced to stop.

Training in the vibration method was begun at about the same time as the training in Braille. They began with the reception of communication. The instructors tried to get the children to associate commands such as "stand up!" or "sit down!" with the actual motions. Two months of training in the vibration method yielded no results with Tadao. Shigeko, on the other hand, could not even be made to keep her hand on the instructor's mouth until he had finished his utterance, so her training was discontinued immediately.

This briefly describes the training of these children before we met them by chance in the fall of 1951 and before our own training was begun in the summer of 1952. Our concern at that time was why this extensive training did not produce any notable effects, although the very same training methods had proved to be so successful in the cases of Laura Bridgman and Helen Keller.

Analysis of Problematic Situation

Confronted with this situation and seeking a better solution to the problem of training these deaf-blind children in verbal behavior, we reexamined the differences in subjective conditions between normal and deaf-blind persons which influence the formation and development of behavioral organization, especially those aspects of behavioral organization relating to verbal behavior.

I will try to illustrate these differences through the use of diagrams. Definitions are omitted as much as possible for the sake of simplicity.

(1) Fig. 1 represents the subject (S) and the environment (E) for each deaf-blind (DB) and normal (N) individual. E is divided into two parts, one being the area of certainty in the environment (EC) and the other being the area of uncertainty in the environment (EUC). EC is the area or "territory" where S's behavior is well-organized and free to develop. EUC is the area where S's activities cannot freely develop.

Fig. 1.

This figure shows that the ratio of EC to EUC is different in DB and N. Shigeko walked around by herself in the school building, but once she was taken out to the playground and left alone she would crawl around on all fours and scream. This violent emotional response continued for a while even after someone approached and touched her. Tadao did not scream but he clasped his hands tightly together and just stood there as if lost. In general, with DB the area of environmental certainty expands very slowly.

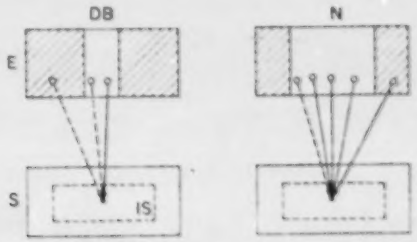


Fig. 2.

(2) In Fig. 2, the circles representing S and E in Fig. 1 are redrawn into rectangles to show the difference between DB and N in relation to how S receives signs

from E. It assumes an intermediation system (IS), which mediates between the reception of signs and the development of activities, as shown by the square drawn with dotted lines. The small circles in E represent events and the arrows represent the direction of signs received by S. Black dots in IS represent the focal points of the signs. The solid arrows and dotted arrows show that these two groups of signs are not received simultaneously. N can receive many kinds of signs from a wide area of E simultaneously, while DB can receive only a few signs from a narrow area of E. However, we observed that Shigeko made efforts to receive simultaneously more signs from a wider area by using her feet, lips, jaw, or body in addition to her hands. On one occasion she discovered that a window which had been missing a glass pane for some time had been repaired. She immediately rushed to another window ten meters away to see whether it, too, had a new glass pane. We could say from observing her behavior that she related through IS the signs that she received sequentially, rather than simultaneously.

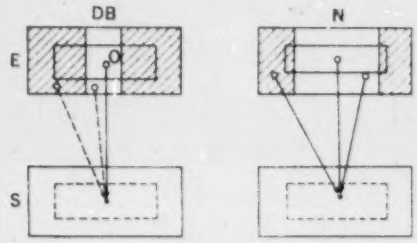


FIG. 3.

(3) Fig. 3 represents a situation where E contains organisms (O) other than S, including other human beings. The O is shown by the square in E area on the figure. The ways of receiving signs from O (O-signs) and from that part of E not including O (E-signs) are different for DB and N. Here, too, N can easily receive O-signs and E-signs simultaneously but this is very difficult for DB. In the earliest stage of language training for Tadao and Shigeko, the instructors made them touch a piece of candy and then let go of it to touch the Braille. This in effect delayed them from eating the candy and might have made it more difficult for them to perceive that the two signs were related.

(4) O-signs can be classified into several types according to the way they are presented and each has its own specific effect on S's behavior. Therefore, O-signs must be treated differently from E-signs. Table 1 shows the classification of O-signs.

TABLE 1
Classification of O-Signs by Principles of Presentation.

O-Sign
1. Aboriginal
2. Constructive
2-1. Symbolic
2-2. Pattern Discriminative
2-2-1. Gestalt-Qualitative
2-2-2. Synthetic

When O's behaviors, such as his responses or traces of them (e.g., his footprints or smell), his motions, and so forth, become signs to S they are referred to as Aboriginal Signs. The bee-dancing studied by von Frisch (1950) is an example of Aboriginal Signs. In contrast to Aboriginal Signs, Constructive Signs are when O forms particular patterns with his voice, his gestures, or with other materials and these patterns thus constructed become signs to S. To become a sign to S here means that what has been constructed by these particular patterns and the events that S can discriminate are placed in a relationship of correspondence and transformation.

Constructive Signs are further divided into Symbolic Signs and Pattern Discriminative Signs. By Symbolic Sign is meant that what is constructed keeps certain characteristics of the event to which it corresponds. Most gestural signs used by the chimp Washoe studied by Gardner and Gardner (1971) are Symbolic Signs. Pattern Discriminative Signs are subdivided into Gestalt-Qualitative Signs and Synthetic Signs. A Gestalt-Qualitative Sign is based on features which only enable S to distinguish it from each other, rather than on qualities similar to the event it stands for. The red cube (corresponding to a banana) and the blue trigonal prism (corresponding to an apple) used by the chimp Sarah in Premack's study (1971) exemplify Gestalt-Qualitative Signs, since the shape and color of the signs are not related to the characteristics of the corresponding objects. A Synthetic Sign is composed of more basic elements, such as phonemes or alphabetic units, drawn from a finite set and arranged in a certain order which serves to distinguish one sign from another. The sounds "Papa", "Mama", "cup", and "up" produced by chimp Viki in Hayes' study (1951) are examples of Synthetic Signs. Because both Gestalt-Qualitative Signs and Synthetic Signs bear little resemblance to their corresponding events, these two are classified together as Pattern Discriminative Signs.

The spoken and written language of normal people, as well as the Braille used by the blind and the manual alphabet used by the deaf, are primarily Synthetic Sign systems. Onomatopoeia and mimesis in the spoken language of normal people or the hieroglyphs in the written language might be considered Symbolic Signs. However, many of the Chinese characters have become Gestalt-Qualitative Signs. Moreover, among the Synthetic Signs of the spoken language there is a symbolic aspect in addition to the Pattern Discriminative aspect. The symbolic aspect of speech is referred to as phonetic symbolism.

(5) Table 2 is provided to give an overview of how useful Constructive Sign systems are depending on 1) the principle under which the signs in the system are constructed, and 2) the ease with which the signs in the system can refer to events of different degrees of differentiation in the event system.

TABLE 2
Relation between Degree of Differentiation in Event System and Usefulness of Constructive Sign System.

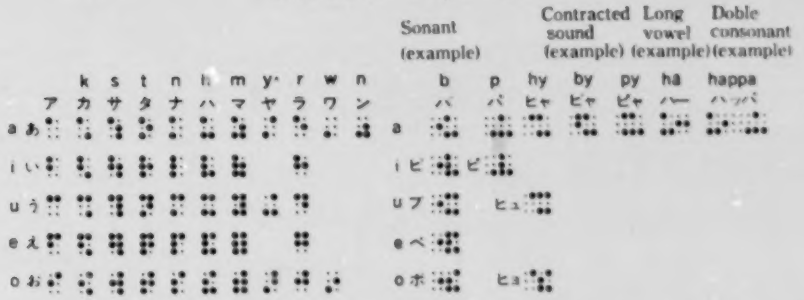
Principle of Construction		Degree of Differentiation in Event System: Low → High
Symbolic		○ ——— ×*
Pattern Discriminative	Gestalt-Qualitative	△ ——— △*
	Synthetic	× ——— ○*

In Table 2, ○, △, and × represent, in this order, the degree of usefulness of Constructive Sign systems. Usefulness here has two implications: 1) a sign system is useful if the signs are easily available; and 2) a sign system is useful if its units are available for recombination and synthesis in order to create new signs of a higher order. The circle in the upper left of the table represents the first type of usefulness, while that in the lower right represents the second.

When the two deaf-blind children began their language training, phenomena corresponding to the left side of Table 2 were observed. In other words, they had established about thirty different gestural signs, but they showed no indication of developing familiarity with Braille or with the vibration method. With DB, gestural signs are limited to those that tactually or motorically simulate the events they stand for. For example, to communicate the idea "let's wash our face" to a DB, the sender of the message has to hold DB's hands and rub them over his face. In other words, the gestural signs of DB mean that the gestures must be made by the recipient of the message rather than the sender. In contrast, the deaf can have a rich repertory of symbolic gestural signs to be received visually. The DB, therefore, has far fewer gestural signs available than the deaf, and this limitation becomes even more pronounced as he advances in differentiating and integrating the event system, which involves dealing with higher order abstract concepts.

Braille, which the children refused to learn at the beginning of their language training, may be considered as the most typical Synthetic Sign system on the basis of its principles of construction. Table 3 shows the basic units of Japanese Braille. One to six raised dots are distributed in specific positions within a 5.5 by 3 mm. space to form 63 different arrangements. It is difficult to distinguish one letter from another, especially tactually. The difficulty is compounded, however, when one tries to distinguish entire words composed of combinations of these 63 units.

TABLE 3
Japanese Braille Syllabary.


Sonant (example)
Contracted sound (example)
Long vowel (example)
Doble consonant (example)
k s t n h m y r w n
b p hy by py hā happa
ア カ サ タ ナ ハ マ ヤ ラ ワ ン
バ パ ヒャ ビャ ピャ ハー ハッパ
a あ
i い
u う
e え
o お
i ヒ ビ ピ
u フ ヒュ
e ヘ
o ホ ヒョ

The vibration method is more difficult than Braille for the DB, both in sending and in receiving. He lacks feedback control with regard to both his auditory and visual systems, even if his motor system for vocalization is not impaired.

In general, there are two reasons why it is harder for N and especially for DB to adopt a Synthetic Sign system as compared with other types of system. First, there is no similarity between the sign and the event it represents. Second, it is often difficult to discriminate one sign from another. However, when these difficulties have been overcome, a Synthetic Sign system is the most appropriate for dealing with highly differentiated (more abstract) events.

(6) Constructive Signs from O are received by S together with Aboriginal Signs from O and E-signs. (Hereafter the latter two are treated simply as E-signs.) What effect this will have on S is illustrated in Fig. 4.

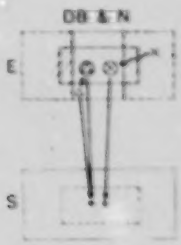


FIG. 4.

These effects can be classified into two groups. One is where S simultaneously receives E-signs from an event △ which belongs to EC for S and other signs ⊗ constructed by O as to the event △. The other is where S receives a sign ⊗ from O about event × which belongs in EUC for S but in EC for O. The first of these has a strengthening effect, in the sense that it gives an orientation to S's behavior. The second has an informative effect, in the sense that it decreases the EUC of S.

Fig. 4 is not differently figured DB from N, but Fig. 3 shows that the EUC for DB is larger than the EUC for N. Furthermore, DB has greater limitations on the simultaneous reception of different signs. Therefore, it can be concluded that Constructive Signs from O have greater informative and strengthening effects on DB than on N.

It may safely be said that the gestural signs thus established in DB, though small in number, have assisted them in making smooth transition from one kind of behavioral act, such as playing, to another, such as eating.

(7) For the sake of clarity, I have thus far only dealt with situations in which S receives signs. Now I would like to discuss situations where S is the initiator of signs. These can be classified into two categories.

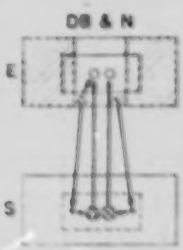


FIG. 5.

i) Fig. 5 illustrates the situation where O as the recipient of signs from S is included in E. Here the roles of S and O are reversed from those in Fig. 4. If you refer to section (6) above, no further explanation should be necessary. The (×) in Fig. 5 is an event × wnich is in EC for S but EUC for O. Here again, DB is not

figured differentiated from N but it is clear from Fig. 2 that when DB and N are in the same E there are very few events belonging to EUC for N but to EC for DB. The rare exceptions are primarily events occurring internally to S, such as emotions or internal sensations, which do not manifest themselves on the surface as Aboriginal Signs. Among the gestural signs established in our two DB's, there were few that they could initiate on their own. When the physical distance between O and DB increases, O becomes part of the EUC for DB. Not knowing whether he has O's attention naturally discourages DB from sending Constructive Signs.

FIG. 6.

ii) Fig. 6 shows the situation where O is not included in E. In this case, even when Constructive Signs are sent they will have no effect as there is no communicative relationship. However, as this figure indicates, S can produce self-strengthening effects in the process of sending and receiving within himself. This occurs when E-sign from event △ is strengthened by sign ⊘, into which S transforms the former and which S presents to himself. He can also produce self-informative effects (e.g., memory) in repeating the process of self-sending and self-receiving. The E-sign from event × encountered at a certain point in the past can be transformed into a Constructive Sign ⊗ which is retained in the intermediation system. Even when there is no × in the present E, sign ⊗ could be activated (and thus self-sent and self-received) due to some other cause. To DB, who has a larger EUC, the process of self-sending and self-receiving of Constructive Signs has more pronounced effects than for N.

The Constructive Signs used in the self-sending and self-receiving are not necessarily the so-called "comsigns" (Morris, C., 1955). In fact, they can even be private Constructive Signs (Blough, D. S., 1959). However, the stronger the comsign system becomes the greater its tendency to absorb the private Constructive Signs.

The behavior of Shigeko described at the end of section (2) very likely included the self-sending and self-receiving of private Constructive Signs. Upon discovering that the window pane had been replaced her first action was an excited and rapid series of hand movements made with her hand held beside her head. These gestures appeared to be intended only for herself and not to communicate with others, just as a normal person might talk to himself in a period of great excitement. Similar behavior has been observed in numerous other cases.

The conclusions derived from the above analyses are as follows:

i) For DB as well as for N (but even more so), the acquisition of Constructive Signs, especially Synthetic Signs, would play a significant role in daily life.

ii) For DB as well as for N (but even more so), it is difficult to acquire usable Constructive Signs, especially Synthetic Signs.

iii) We consider our DB to have been at the following stage as far as the acquisition of Synthetic Signs is concerned. They were beginning to show progress in differentiating events but had not yet come to explore the subtle yet precise differences so crucial to the discrimination between Synthetic Signs.

Policies at the Start of Our Training Program

On the basis of the conclusions drawn from the above analyses the following policies were established:

i) The acquisition of the Synthetic Sign system was to be aimed as the primary goal.

ii) Among the various forms of Synthetic Sign systems that are thought to be learnable by DB's, we would try to have them master Japanese Braille first. Because Braille is a written system it may not be convenient for conversation, but since it constitutes a permanent record which can be reviewed it can be a sign system of greater security to the DB's.

iii) We would avoid introducing Braille directly at the initial stage of training and would begin, as a necessary detour, with an attempt to systematize the tactile equivalent of "babbling."

iv) The DB's had been spontaneously performing various tasks of pattern discrimination, such as fitting geometric blocks together and sorting "go" stones into those which are more perfectly shaped and those which are irregular. In addition, they were actively playing with the form-boards, as shown in the film. By gradually modifying the tasks the children were to perform, we would lead them to touch the raised dots on paper without resistance and would attempt to nurture in them a more positive attitude toward discriminating the patterns to be found in Braille.

The Training Method

i) The matching technique would constitute the primary training method. However, our intent is to adapt this technique to the communicative relations situation. That is, the "standard" (S) in the matching task is to be considered as a Constructive Sign presented by the instructor. The choice items (C) are thought of as the repertory of receiving behavior of DB. (See the series of figures and tables beginning with Fig. 7 and Table 4.) The receiving behavior of DB is his choice of one item from among the set of choice items and his handling it in a predetermined appropriate way. The receiving behavior is followed by a gestural sign from DB meaning "give me," in anticipation of a reward for completing the task. On receiving this message, the instructor offers a small amount of candy to DB if his choice was correct. If it was wrong, the instructor would call for a retrial or would correct DB's response and then give candies.

ii) For a while we would use only choice items which are in a symbolic constructive relationship with the standard.

iii) Only after assuring that the objectives of one step have been fully achieved would we advance to the next step. When the rate of correct responses at a given step does not increase despite repeated trials, we would assume that our step provision was inappropriate to their abilities at the time. Instead of giving more trials at that particular step, we would create a smaller step and only after the goals of the smaller step had been reached would we return to the step that had been suspended.

EXECUTION

With "the formation of receiving behavior through Braille" as the primary goal, "the discrimination of geometric patterns formed by lines made up of raised-dots" as the major sub-goal, and with "pattern discrimination of the form-board type" as the first step, we began our training program, gradually advancing the steps and sub-goals until signalization in Braille was established. The steps taken are shown in Table 4 and in Figs. 7 to 9.

TABLE 4

Steps Leading to the Acquisition of Braille.

These steps were used in the initial period until the correspondence and transformation between objects and their representations in Braille were established. The numbering of examples in Figs. 7 through 9 corresponds to the steps in this table.

1. *Matching on the basis of shape.*

Step	Problem
1-1	S (standard): One of 5 wooden form-boards each containing a hole of a different shape. C (choice items): 5 wooden pieces corresponding to these holes.
1-2	S: One of 4 tactile figures (composed of raised dots). C: 4 wooden pieces of corresponding shapes.
1-3	S: One of 4 tactile figures of different shapes and two different sizes. C: 4 wooden pieces of corresponding shapes but an intermediate size.
1-4	S: Same as 1-2. C: 4 pieces in different shapes and different materials (wood, glass, sandpaper, and wire frame).
1-5	S: Same as 1-2. C: 4 corresponding tactile figures on one sheet of paper.
1-6	S: One of 4 tactile figures rotated from their usual orientations, by 180, 90 or 45 degrees (no change, of course, for circle). C: 4 corresponding tactile figures in their usual orientations.
1-7	S: Same as in 1-2. C: 4 tactile figures differing in shape from S. (C is to be classified according to degree of similarity to S.)

2. *Matching on the basis of position in a frame.*

Step	Problem
2-1	S: Frame formed by square tactile figure (6 × 6 cm) with an indicant (I) consisting of a triangular tactile figure (1.5 cm each side) in one of two positions in the frame (upper left or center). C: Two similar frames (5 × 5 cm) with I (here a circle .5 cm in diameter) in either of the two positions possible for S.
2-2	S & C: Same as in 2-1 with the addition of a third positional possibility (lower right).
2-3	S & C: Same as in 2-2 with triangular I replaced by circle (.5 cm in diameter). (Problems are to be easier step-by-step till 2-7.)
2-4	S: Cardboard frame with triangular hole in one of two positions (upper left or lower right). C: Two cardboard frames identical to the two possibilities for S.
2-5	S: Plywood frame (9 × 3.5 cm) with large raised dot (thumbtack head, 1 cm in diameter) in one of 3 positions (upper, middle, lower) and small raised dots (pinheads, .3 cm in diameter) in the remaining two positions.

C: 3 plywood frames identical to the three possibilities for S.

2-6 S: Same as in 2-5 except that more pinheads are used to create raised dotted line through longitudinal center of frame.
C: 3 plywood frames identical to the three possibilities for S.

2-7 S: Plywood frame as above with two holes of different shapes. Possible shapes are square (2.5 cm each side), circle (2.5 cm in diameter), triangle (2.5 cm each side).
C: Plywood frames corresponding to each possibility for S.

2-8 S & C: Same as 2-5, but rotated 90 degrees.

2-9 S & C: Same as 2-6, but rotated 90 degrees.

2-10 S: Plywood frames of the same type with a thumbtack head in one of two positions (upper left or lower right) and a pinhead in the remaining position.
C: Plywood frames corresponding to each of the possibilities for S.

3. *Matching on the basis of pattern recognition.*
(In all cases S is identical to some C; therefore, only C is treated below.)

Step	Problem
3-1a	Frame (6 × 4 cm) containing circular tactile figure (1.2 cm in diameter) in one of 6 positions (2 columns × 3 rows).
3-1b	Frame as above containing 1, 2, 3, or 4 circular tactile figures with only one pattern for each number of figures.
3-1c	Frame as above containing 3 circular tactile figures. Three patterns, each pair of which shares the position of only one figure in common.
3-1d	Frame as above containing 3 circular tactile figures. Same pattern in two possible positions (upper or lower).
3-1e	Frame as above containing 3 circular tactile figures. One pattern and its mirror-image.
3-1f	Same as 3-1e with mirror-image inverted.
3-2a	Frame and figures reduced to 2/3 size of 3-1. Number of figures always 3.
3-2b	Same as 3-2a, but number of figures is always 4.
3-2c	Same as 3-2a, but number of figures is always 5 or 6.
3-3	Size of frame and figures further reduced to 2/3 of 3-2. Substeps of 3-3 use 1, 2, 3, 4 or 5-or-6 figure patterns.
3-4	Same as 3-3, but with no frame.
3-5	Same as 3-4, but further reduced to 3/4 of 3-4 in size.
3-6	Same as 3-5, but further reduced to 2/3 size of 3-5. Frames here are made of wood and figures are pinheads.
3-7	Same as 3-6, but with tactile figures.
3-8	Same as 3-6, but with size further reduced to 2/5 of 3-5.
3-9	Standard Braille figures with no frame. Each unit covers an area of .55 × .3 cm.
3-10	Standard Braille. 2-letter sequences in which first letter has 6 dots and second has 1 or 2 dots.
3-11	Same as 3-10 but with no restriction on number of dots for either letter.
3-12	Standard Braille. 3-letter sequences. Otherwise same as 3-11.

4. *Matching of objects with their names in Braille.*

Step	Problem
4-1	S: Either a comb or a plate with an identification card (6.8 × 9.5 cm) firmly attached on which name of object is written in Braille. This requires two letters in the Japanese Braille syllabary. C: A sheet of paper (13.5 × 19 cm) on which the names of the two objects are written in Braille.
4-2-1	Same as 4-1, but with identification cards placed near the object and not attached.

4-2-2 Same as 4-1, but with no identification card. Only if DB does not choose and searches for card will card be given.

4-3 S: Either a kettle or a spoon with the name of the object written in Braille on an accompanying identification card. These words require 3 letters in the Japanese Braille syllabary. Otherwise the same as 4-2-2.

4-4 S: One of the four objects mentioned above (comb, plate, kettle, or spoon).
C: Sheet of paper with names of all four objects in Braille.

4-5 S: One of the four identification cards.
C: All four of the objects.

4-6 S: Same as in 4-5.
C: Same as in 4-5, except that some objects are smaller or larger than those used previously.

4-7 Same as 4-6, but with C at a greater distance (1.5 m) from S.

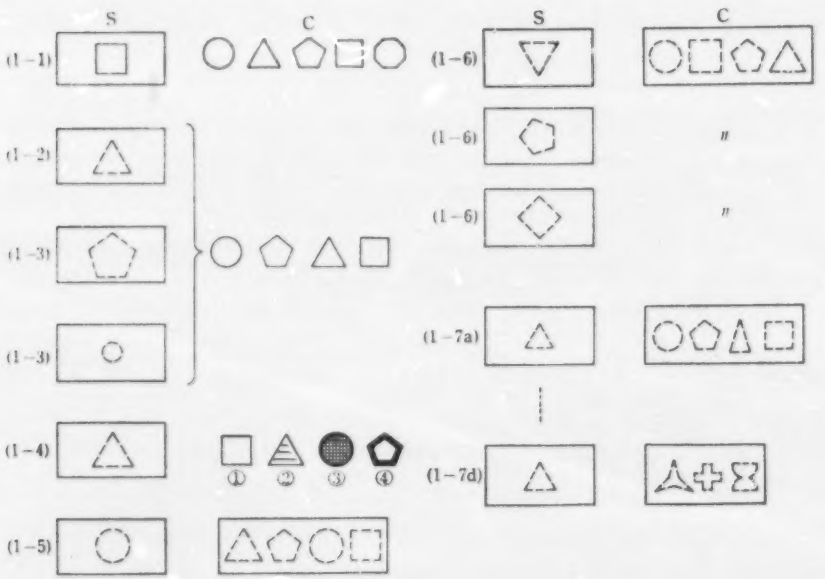


FIG. 7.

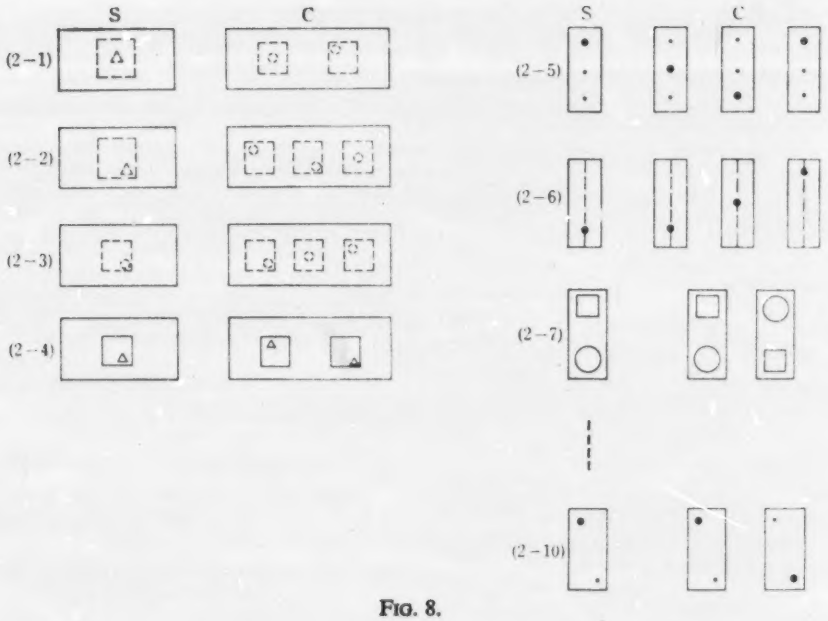

S
C
(2-1)
(2-2)
(2-3)
(2-4)
S
C
(2-5)
(2-6)
(2-7)
(2-10)

FIG. 8.

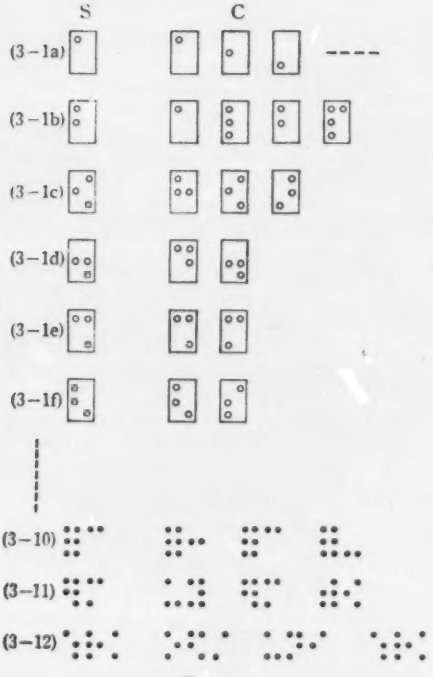

S
C
(3-1a)
(3-1b)
(3-1c)
(3-1d)
(3-1e)
(3-1f)
(3-10)
(3-11)
(3-12)

FIG. 9.

Once signalization was established continued efforts were made to increase the children's repertory of Braille signs and to promote the systematic synthesis among items in the repertory. In addition to the event system relevant to everyday life, they have come to learn special operational systems such as the number system, the space system, the time system, the social relations system, and the physical hygiene system.

After the Braille system had been established to a certain extent, the vibration method and the manual alphabet were also introduced. The step development of the vibration method is shown in Table 5. The children were first taught to vocalize the vowel "a," which is one of the basic speech sounds of Japanese, and then to vocalize the other basic speech sounds of Japanese (4 other vowels, 65 CV syllables, 24 CCV syllables, and 1 consonant). Even though their pronunciation was imperfect, they progressed to the point where their vocalizations were distinguishable by normal persons hearing them. (However, they were not trained thoroughly in receiving signs by the vibration method.)

TABLE 5

Steps in the Acquisition of the Vibration Method.

The initial stages in learning to produce vocal signs. A brief summary of the procedures leading to the acquisition of the sound "a."

1. *Control over lip formation.*

Step	Problem (and result)
1-1～3	After matching the Braille letter "a" (or "i" or "u") with a pattern card cut out to show the shape of the lips in articulating "a" (i,u), the subject is instructed in Braille to open his mouth in that shape. He places the pattern card over his mouth and shapes his lips to fit the pattern. Later he does this without the use of the pattern card.

2. *Control over breathing (especially exhalation).*

Step	Problem (and result)
2-1～5	Practice with inflatable objects, such as a soft rubber ball, a safety-jacket, or an air pillow. While the subjects could deflate an object when instructed to do so, they were unable to inflate one. All they would do was to hold the object to their mouths.
2-6～9	Use of a feeding cup. After practice in sucking or blowing water through the mouthpiece of a feeding cup, the subjects returned to step 2-5. When instructed to inflate a ball they could sometimes manage to inflate it a bit.
2-10～13	Practice in supportive activities. Under instruction in Braille they practiced holding their noses with their fingers, pressing their bellies, holding their arms high, etc. Later they were able to produce these actions when instructed to inflate a ball, and they did so with little or no help from others. (Although we had hoped that these actions would increase their capacity to inflate objects, very little was obtained in the way of favorable results.)
2-14～17	Use of an inhaler mask. When instructed to put on the mask and blow up a ball they were able to inflate the ball quite well. (The mask functioned to prevent leakage of air from the nose and from the sides of the mouth.)
2-18	Use of a bugle. A small bugle was substituted for the inhaler mask. The subjects were instructed to blow into the larger end of the bugle and the object to be inflated was attached to the smaller end. Later, the object was removed and the subjects were asked to place the palms of their hands near the smaller end of the bugle so that they might feel the force of the exhaled air on their palms.

	Finally, they were able to follow the instruction to form their lips in the shape of "a" and exhale.

3. *Control over throat tension.*

Step	Problem (and result)
3-1∼5	Subjects were taught to discriminate a "hard ball" from a "soft ball," a "stiff arm" and a "soft arm." They were instructed to clench their fists in order to stiffen their arms and then to open their hands in order to relax and soften their arms.
3-6∼7	After learning to differentiate between a tense throat and a more relaxed throat, the subjects were asked to "press the throat hard and stiffen the inside of the throat."

4. *Integration of* **1**, **2**, *and* **3**.

Step	Problem (and result)
4-1∼2	The subjects were instructed to combine the last instruction of 2-18 (to form their lips in the shape of "a" and exhale) with the last instruction of 3-7 (to press the throat hard and stiffen the inside of the throat). A sound that was heard as "a" occurred on the second trial.

Since the Japanese language has a large number of basic sounds the manual alphabet used by the Japanese deaf has a large number of signs corresponding to them. (In addition to the 46 basic units, there are 4 supplementary movements representing long vowels, double consonants, etc.) Since there is a standard spelling for the Japanese language in the Roman alphabet, however, we decided to use the manual alphabet based upon this spelling. With this alphabet it was only necessary to have 19 different units (5 vowels and 14 consonants). This training proceeded almost without difficulty and was immediately put to practical use in conversation.

Discussion

The above has been a summary of the problems confronted by our first two cases of children who had been totally deaf and blind from an early age and how they overcame these difficulties. I would now like to present a few thoughts that have grown out of our experience with these children.

i) In the kind of action research that we have carried out, it is not defensible to provide a control group for the testing of hypotheses if varying the experimental conditions will subject the children to circumstances that are likely to be harmful to them. It is for this reason that it becomes important to make explicit the hypotheses of the researcher that have given direction to the research and supported its procedures. Only then can we properly evaluate our own work and be prepared for criticism from others.

ii) I have no intention of claiming that our policies, training methods, goals and sub-goals, or step-provisions were necessarily the most appropriate for the children at that time. I do not think that in developing verbal behavior in DB people the same policies and the same methods used for the two DB discussed above must necessarily be used. In fact, in dealing with other deaf-blind individuals we have adapted our policies and methods to meet the needs of each case. If we had encountered a deaf-blind child like Helen Keller it is quite possible that we would have used the same methods that Miss Sullivan used.

iii) Among the characteristics of human language most often mentioned, some, such as immediate transfer and the spontaneous combination of previously acquired signs, have been found to occur in subhuman primates when Constructive Sign systems appropriate for them are formed (cf. the studies by Premack and the Gardners discussed earlier). These properties were also observed in our DB as soon as signalization in Braille occurred. That this happened is probably due to the fact that the children had advanced to a level where the differentiation and integration of the event system and the item differentiation within the sign system could be utilized in this way. One cannot say that either the event system or the sign system is always the initiator, but rather it may be that the two are in a relation of mutually stimulating differentiation and integration. It is difficult to assume that the properties of transfer and combination exist only within the innate structure of the user of the sign system.

iv) Even when one says that a DB has acquired "language," it does not necessarily mean that he has acquired the language of the normal. However, this does not imply that a communicative relationship at the level of a Constructive Sign system cannot be established between the deaf-blind and the normal. This relationship is illustrated in a slightly exaggerated fashion in Fig. 10. The blacked-in portion showing the overlap between DB and N in both the sign system and the event system is the area where communication can be established between DB and N.

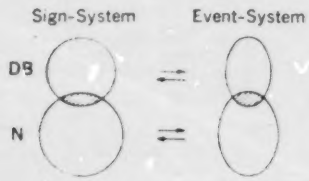


FIG. 10. Communicative Relation between DB and N.

It is incorrect to treat the sign system of DB as totally unique or as inferior to that of N. It is unique in some respects but also shares certain properties with that of N. Similarly, the sign system of N has its own unique aspects. Yet it is only in this area of shared properties that communication is possible. A similar relationship holds among speakers of different languages or even, to some degree, among speakers of the same language.

v) Thus, in evaluating the degree of acquisition of verbal behavior in a DB, comparing the size of his vocabulary or his rate of acquisition with that of another DB or, especially, with that of an N, does not seem to have much validity. Rather, it would be much more meaningful to examine the degree to which his behavior has become better organized as compared with the period before verbal behavior was acquired. This holds true not only for the DB but also for the N. The essential role which a Synthetic Sign system can play as a subsystem of the intermediation system (IS) is to assist in the formation of behavioral organization of a higher order and to support its realization in any environmental situation.

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